EXHIBIT 11

United States Patent [19]

Ryan

[11] **Patent Number: 4,503,466**

[45] **Date of Patent: Mar. 5, 1985**

[54] **APPARATUS AND METHOD FOR GENERATING OPTIMIZING PICTURES UNDER LOW LIGHT CONDITIONS**

[75] Inventor: **John O. Ryan**, Cupertino, Calif.

[73] Assignee: **Ampex Corporation**, Redwood City, Calif.

[21] Appl. No.: **351,399**

[22] Filed: **Feb. 23, 1982**

[51] **Int. Cl.**³ **H04N 5/34**

[52] **U.S. Cl.** **358/211; 358/219**

[58] **Field of Search** 358/211, 209, 219, 222, 358/243, 310, 312, 313, 332, 345, 346; 315/386

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,090,829	5/1963	Lee	358/211
3,652,154	3/1972	Gebel	358/211
3,716,657	2/1973	Niemyer	358/211
4,133,009	1/1979	Kittler	358/313
4,331,980	5/1982	Ryan	358/219
4,340,909	7/1982	Yamada	358/213
4,389,610	6/1983	Davidson	358/211

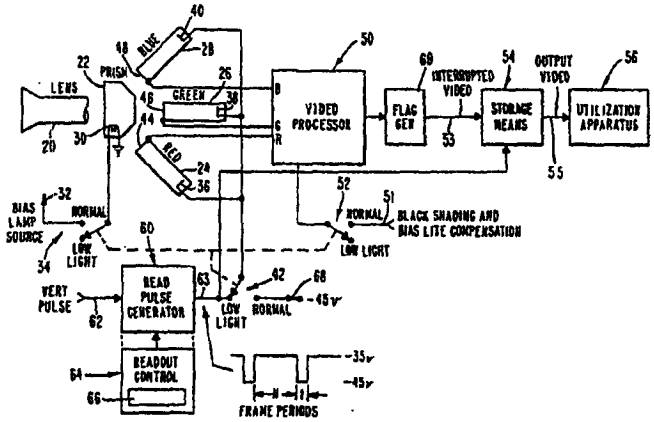
Primary Examiner—Tommy P. Chin

Attorney, Agent, or Firm—George B. Almeida; Joel D. Talcott

[57] **ABSTRACT**

The scanning process of a television camera is modified so that scanning is inhibited for N successive scan periods and is enabled during the next scan period, in a repeating cycle of (N+1) periods duration. The signal output generated during the N inhibited scan periods is zero but, during the enabled scan period, is (N+1) times greater than the corresponding signal which would be generated by conventional scanning action.

8 Claims, 7 Drawing Figures



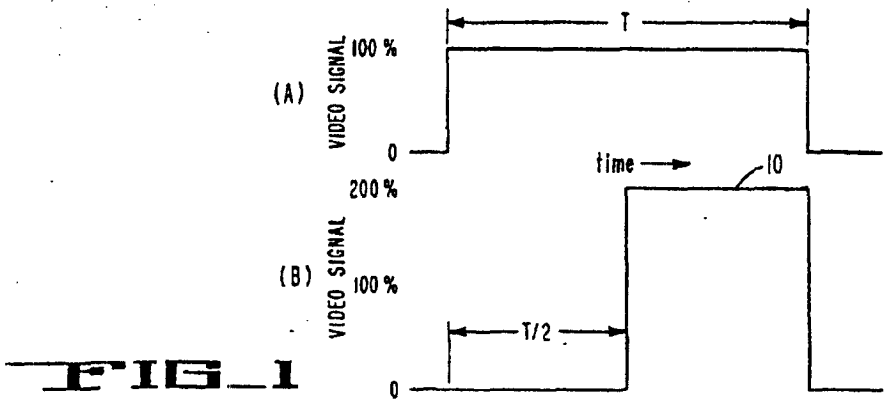


FIG_1

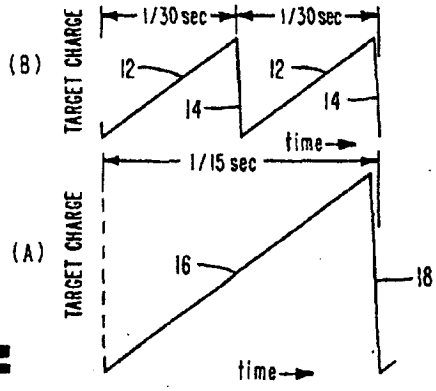


FIG_2

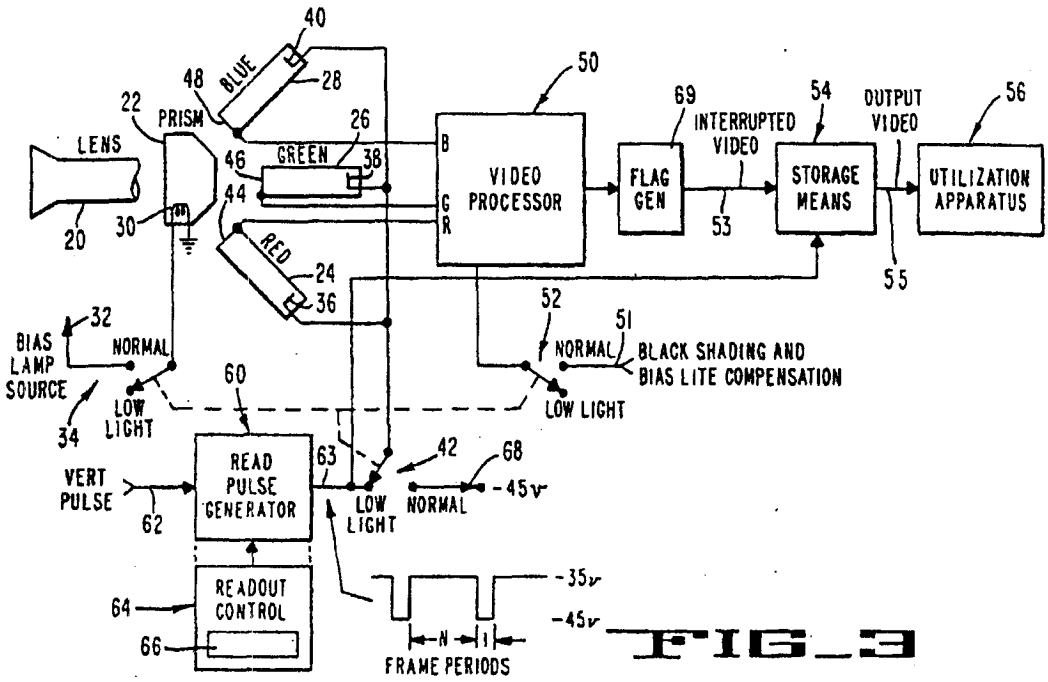


FIG_3

AXD033392

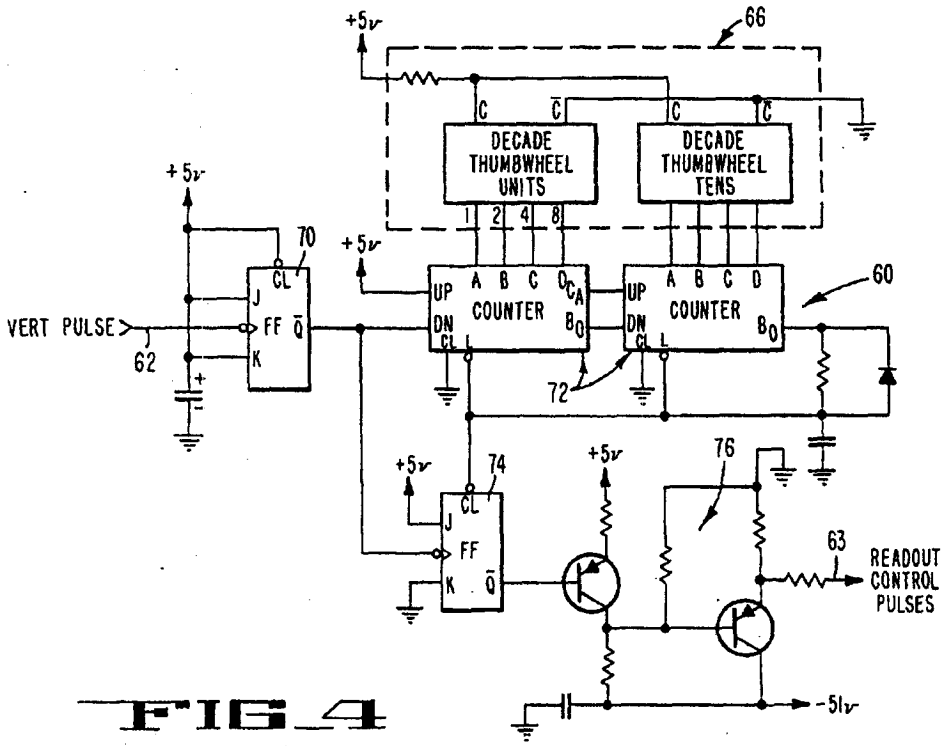

+5v
66
DECADE THUMBWHEEL UNITS
DECADE THUMBWHEEL TENS
1 2 4 8
70
CL
J
FF
K
VERT PULSE
62
UP
DN
CL
A B C D
COUNTER
60
72
74
76
63
READOUT CONTROL PULSES
-5lv

FIG_4

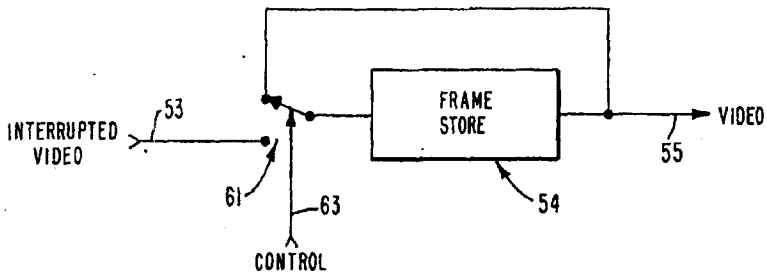

INTERRUPTED VIDEO
53
FRAME STORE
VIDEO
55
54
61
63
CONTROL

FIG_5

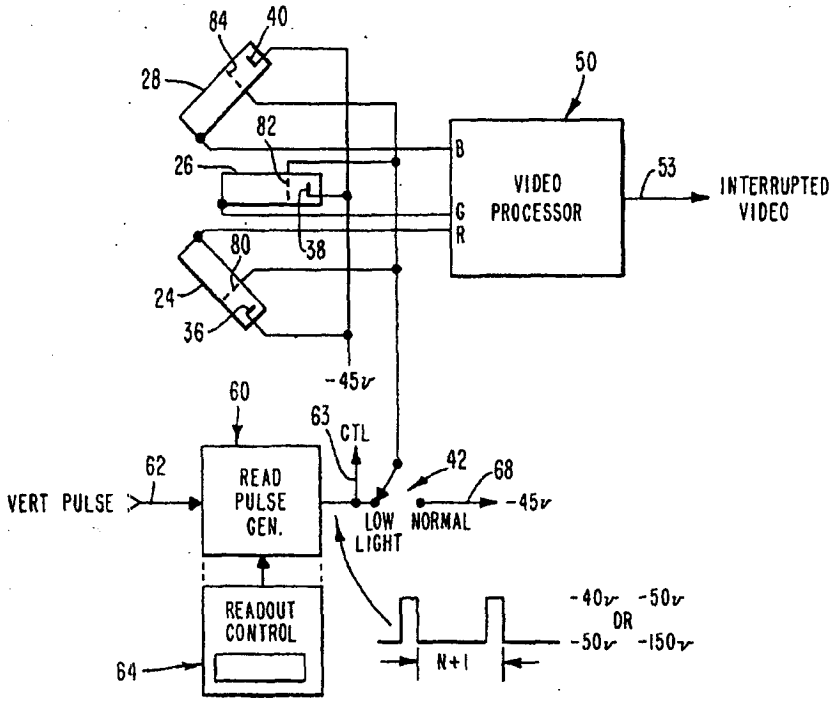


FIG_6

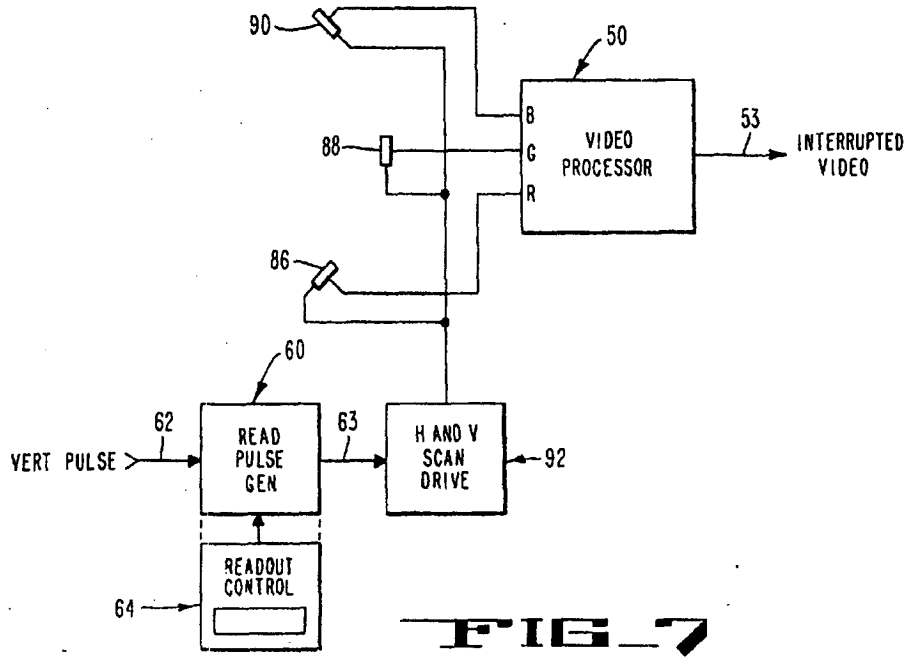


FIG_7

AXD033394

APPARATUS AND METHOD FOR GENERATING OPTIMIZING PICTURES UNDER LOW LIGHT CONDITIONS

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates to means for generating a high quality picture under very low ambient light conditions, and particularly to apparatus and method for producing high quality monochrome or color television pictures under conditions of very low ambient illumination.

In the field of television, and particularly in the fields of electronic news gathering (ENG), electronic field production (EFP), surveillance, etc., there are many instances such as, for example, under twilight or heavy overcast conditions, wherein television cameras cannot be utilized successfully due to the lack of sufficient ambient light to allow recording a scene. Under such low light level conditions, news gathering or other activities using television cameras are precluded, thereby limiting outdoor use of television cameras to daylight hours, or at best, early evening situations. Likewise, closed circuit surveillance systems are limited generally to indoor or outdoor applications where there is sufficient artificial lighting to allow the use of conventional industrial television cameras.

The only known low light level cameras are various types of highly specialized surveillance devices as those used, for example, by the military. Such devices are generally monochrome systems using special image intensifier tubes, are very expensive, and under normal illumination conditions are generally incapable of making color television pictures of a quality suitable for broadcast purposes. Thus such specialized devices can be used only for their intended purposes.

The invention overcomes the shortcomings of the above mentioned devices, by providing a relatively simple system for producing high quality moving or still color television pictures, under conditions of very low ambient illumination. Further, the system is applicable to present high quality cameras utilizing conventional image pickup tubes, which cameras inherently are capable of, and intended for, generating broadcast quality pictures under normal light level conditions. Thus a particularly valuable and heretofore unavailable application of the invention combination is in the field of electronic news gathering. An ENG camera with the capability of readily being switched to a low light level mode of operation permits the capture of newsworthy events which occur outdoors in deep twilight. At present, this has been well outside the capability of all existing ENG, or of all EFP cameras. As further described below, the primary drawback of the system is that the video signal is "interrupted"; i.e., the resulting pictures which are generated do not occur at the usual frame rate, and thus are discernable by a viewer as successive pictures of the scene. However, in accordance with the invention combination, various schemes are contemplated for generating continuous video pictures from the interrupted signal. In any event, when newsworthy events occur, successive periodic pictures of the scenes are far preferable to not being able to obtain any pictures at all.

Accordingly, the invention combination utilizes the principle that the signal current generated by a television image tube, or other similar sensor, throughout a specific time interval corresponding to a specific area of the imaged scene, is directly proportional to the corresponding illumination level on the sensor and to the integration time, i.e., to the period between successive scans of the specific area. In conventional television cameras, the integration time is fixed and is equal to the reciprocal of the picture repetition frequency, i.e., to the frame frequency (1/30 of a second in the NTSC color television standard, and 1/25th of a second in the PAL standard). In the invention combination, the scanning process used in a television camera is modified to inhibit scanning for N successive frames and to enable scanning during the next frame period, in a repeating cycle of (N+1) frames duration. It follows that the signal output from the sensor during the enabled, or "on", frame will be (N+1) times larger than the corresponding signal generated by conventional scanning action. However, the signal output is zero for the N inhibited, or "off", frames, thereby providing the interrupted video signal.

The interrupted video signal may be selectively manipulated to optimumize the final output video signal, depending upon the medium in which the video is to be used, the type or content of the video signal desired, etc. By way of example, the video signal from the camera may be recorded on a suitable video recorder and subsequently replayed in the "still frame" mode. Alternately, the video signal may be fed to a frame store, wherein the gaps in the interrupted video signal corresponding to the inhibited frames can be filled in with video generated during an adjacent enabled frame.

Accordingly, it is an object of the present invention to provide a system and method for producing high quality monochrome or color pictures under very low ambient light conditions.

It is another object to provide quality television signals under low ambient light conditions utilizing generally conventional cameras with conventional image pickup tubes.

It is still another object to provide quality television pictures in a television camera by selectively inhibiting and enabling the readout of given frames of information in a repeating cycle of frames generated by the camera.

Another object is to inhibit the readout of given frames in a repeating cycle of frames by selected manipulation of given elements of the scanning devices.

A further object is to provide optimum still or moving television pictures in low light conditions while still providing broadcast quality television signals during normal light level conditions.

A still further object is to optimize the effective sensitivity of an optical-to-electrical transducer under low ambient light level conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A–1B is a graph illustrating video output signals for a camera without and with the invention system. FIGS. 2A–2B is a graph illustrating the charges on a given small portion of a target without and with the invention system.

FIG. 3 is a block diagram depicting one implementation of the invention combination.

FIG. 4 is a schematic diagram illustrating in further detail the block diagram of FIG. 3.

FIG. 5 is a block diagram exemplifying frame store apparatus for use in the system of FIG. 3.

FIGS. 6 and 7 are block diagrams of alternative embodiments of the invention combination.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For simplicity of description, it is assumed that a television camera is directed at a perfectly white chart, and thereby produces a constant white level video output signal, such as depicted in FIG. 1A. Given a signal of an undefined period of time T, if the area under the curve is effectively measured, it defines the total light that impinges the camera lens and the target of the tube thereof for that period of time T. Thus the signal may vary from zero at the base line, to 100% at its white level for the time period T.

If the scanning action is altered such that there is no readout during the first half of the time period T (FIG. 1B), and then there is readout during the second half of the period T, the resulting video signal 10 is zero for the first half and is twice the value of the 100% video signal for the second half of the period T. However, the area under the curve of the FIG. 1B is identical to that under the curve of FIG. 1A. Thus it may be seen that the signal generated on the target of the tube is dependent upon the intensity of the light and also upon the amount of time the light fell on the target.

In conventional television camera operation, the incoming light falls on the target for one frame (i.e., 1/30 second in the NTSC color television standard), whereupon the electron beam reads out (i.e., scans) the signal charge on the target for each frame to provide the corresponding television signal at 30 frames/second. In this case, the light has 1/30 of a second to build up an image on any given portion of the target.

Referring to FIG. 2A, it follows that for a constant amount of incoming light the charge at the given portion of the target builds up linearly as a function of time as depicted at numeral 12, since the light is falling constantly with time. After 1/30 of a second, the charge is read out and the video signal drops to zero value, as depicted at numeral 14. Thereafter the charge builds up again during the next 1/30 of a second, is read out again, etc., throughout a conventional scan process.

Referring to FIG. 2B, if the integration period is altered as discussed in FIG. 1B, to enable readout for only one frame out of two, the charge at the given portion of the target builds up to twice the value, as depicted at numeral 16, since the light is falling on the target for twice the amount of time. The target then is read out by the scanning beam after, for example, 1/15 of a second, as depicted at numeral 18.

In the situation of FIG. 2B, the resulting signal generated by the cameras is an interrupted video signal, viz, the camera output is a single flash of 1/30 second corresponding to a frame of information, i.e., a color television picture, followed by 1/30 second of darkness, followed by another 1/30 second flash of a single frame, followed by 1/30 second of darkness, etc. Therefore, the increase in effective sensitivity, viz, the doubling of the light level of the generated pictures, is accomplished at the expense of being able to obtain only one image in 1/15 second, instead of two images as would be generated in the conventional scan method of FIG. 2A.

Referring to FIG. 3, a simplified television camera system is depicted to illustrate the invention combination, and includes conventional lens apparatus 20, prism apparatus 22 for splitting the light supplied by the lens 20, and red, green and blue camera pickup tubes 24, 26, and 28 for receiving the separated light. Prism 22 is depicted herein as including a conventional bias light arrangement 30, which is coupled to a bias lamp source 32 via a switch 34, and operates in conventional fashion to flood the faceplate of the tubes to correct for lag effects. The cathodes 36, 38, 40 of the tubes 24, 26, 28 respectively, are coupled to the common side of a switch 42. The targets 44, 46, 48 of the tubes supply the red, green and blue color television signals, and are coupled to conventional video processor circuitry 50. Conventional black shading, bias light, etc., compensation circuitry, indicated by numeral 51, is coupled to the video process circuitry 50 via a switch 52. The compensation circuitry conventionally cancels out various detrimental effects on the video signals due to the bias light, black shading, etc.

The interrupted video signal supplied by the processor circuitry 50 herein is shown coupled via a line 53 to video storage means 54 such as, for example, a frame store, etc. The final output video signal is subsequently selectively supplied via a line 55 to a suitable utilization apparatus 56 such as, for example, a monitor, print-out apparatus, photographic camera, etc. The apparatus of storage means 54 and/or the utilization apparatus 56 is determined by the particular use to which the camera system is put.

A read pulse generator 60 receives a vertical sync pulse from the camera system sync generator (not shown) via an input 62 and generates therefrom read control pulses of selectable frequency on a read control line 63. The frequency of the control pulses is determined herein, by way of example only, by the setting on a read frequency control means 64, typically a pair of decade thumbwheels 66 (FIG. 4). Thus the read pulse generator 60 and read frequency control means 64 define a readout control means which inhibits or enables the scanning beam to readout the target, in response to the thumbwheel settings. A number corresponding to the desired readout frequency is dialed on the thumbwheels 66, as further described in FIG. 4. The generator 60 provides the read control pulses via line 63 to one side of the switch 42, and to a control input to the storage means 54 to control input to the storage means 54 to control the cycling of the pictures fed to the storage means. A second side of switch 42 is coupled to a −45 volt source 68 conventionally supplied to the cathodes of the tubes when the camera system is in normal operation. The switches 34, 42, 52 are mechanically connected to switch together.

In operation, when low light level camera operation is desired, switches 34, 42, 52 are switched to the low light level positions shown in FIG. 3. The bias light 30 is turned off since the light generated thereby generally would overpower the low light level from the scene. The compensation circuitry thus is no longer required, and also is disconnected. The cathodes 36, 38, 40 normally coupled to the −45 volt sorce, are coupled instead to the read pulse generator 60, which supplies pulses which vary in amplitude between −35 and −45 volts, at a frequency determined by the setting dialed on the thumbwheels 66. When the cathodes are at −35 volts the readout process is inhibited and the tubes integrate the incoming light. When the cathodes are at −45 volts the readout process is enabled and the target charges are read out to provide the red, green and blue color signals.

More particularly, when the read control signal is at −45 volts, the electron beams of the tubes are allowed to read out the respective targets. When the cathodes are pulled up to −35 volts, no further electrons will

land on the target, readout is inhibited, and the target is allowed to build up charges corresponding to the time duration and the incoming light levels of the scene.

Thus, when the scanning process in a television camera is modified, for example, via the circuit of FIGS. 3, 4, scanning readout is inhibited for N successive frames and is enabled during the next frame, in a repeating cycle of (N+1) frames duration. The signal output from the tube or sensor is zero for the N inhibited frames, and during the enabled frame is (N+1) times larger than the corresponding signal which would be generated by a conventional scanning process. The interrupted video signal is then utilized via the storage means 54 and utilization apparatus 56 of FIG. 3.

More particualrly, the storage means 54 may be a videotape recorder in which the signal is recorded. In subsequent replay, the recorder is operated in the still frame mode whereby the interrupted signals generated by the camera system during the corresponding enabled frames are reproduced indefinitely as successive still pictures, can be fed to a print-out apparatus 56 and printed in the form of hard copies, photographed via a film camera, etc.

In an alternate system, the interrupted signals from the camera system are fed to a frame store, as depicted further in FIG. 5, whereby the inhibited frame time gaps are filled in with the video generated during the previous enabled frame. Thus, the frame store defining the storage means 54 is essentially any device which provides a one-frame delay of digital memory elements. A frame store switch 61 is inserted at the input to the frame store, whereby the output may be fed back to the input thereof. When the frame store is filled with one picture via line 53, the switch 61 coupled the output to the input of the frame store, whereupon the output video is a continuous succession of the stored picture at the normal frame rate. The switch 61 may be controlled, for example, via the leading edges of the read control pulses on line 63. Operation of the frame store 54 may be performed automatically by inserting a suitably timed flag pulse of, for example, a few microseconds length, in the vertical interval just preceding an enabled frame, thus instructing the frame store to enter the "write" mode. In FIG. 3, the flag pulse is inserted in the video signal via a flag pulse generator 69, shown herein as inserted in the output of the video processor circuitry 50. Since the insertion and detection of the flag pulse is conventional, no further description is provided.

The use of a frame store effectively captures the scene as a series of still pictures which occur every (N+1) frames. For small values of N, the effects of motion are reasonable well captured, and of course the effective increase in camera sensitivity is correspondingly small. Larger values of N provide correspondingly larger increases in camera effective sensitivity, however any motion in the viewed image which occurs during the (N+1) frames causes blurring in the resulting pictures fed to the storage means 54.

FIG. 4 exemplifies an implementation of the read pulse generator 60 and the read frequency control means 64 of FIG. 3. The circuit is essentially a counter with a controllable output pulse frequency determined by the settings dialed on the decode thumbwheels 66. That is, the pulse generator 60 supplies an output pulse which is low, i.e., −45 volts, for one frame out of (N+1) frames, wherein the thumbwheels are set at (N+1). To this end, the vertical sync pulse on input 62 is divided by two in a JK flip-flop 70 to provide one pulse per frame. The output is fed to a counter 72, which counts the incoming pulses and generates via a JK flip-flop 74 a single read control pulse output every (N+1) frames. Transistors 76 provide means for transforming the logic level signals of, e.g., 5 volts of the counter to the levels required for driving the tube elements.

Thus if the number 10 is dialed on the thumbwheels, the counter 72 generates one read control pulse of −45 volts for every 10 incoming pulses; a 10-to-1 integration sequence, which provides pictures with 10 times the light of a conventional scan process. If the number 30 is dialed on the thumbwheels 66, one read control pulse is generated for every 30 incoming pulses, with a 30-to-1 integration sequence.

The thumbwheels 66 can be set at numbers ranging, for example, from 2, 3, 4, 5, . . . 15, 20, 30 (corresponding to one picture every second) 60, and even up to 90 (corresponding to one picture every three seconds). To date, useful pictures have been obtained with integration times of from 1/15 to one second, where one second times correspond to five F-stops of extra sensitivity.

Referring now to FIG. 6, an alternate method and circuit for modifying the camera readout process in accordance with the invention, is illustrated. Instead of controlling the cathodes, in the circuit the scanning beam is turned off by driving the grids 80, 82, 84 of the tubes with a suitable pulse. Thus, for example, in a diode-gun type of pickup tube, the read pulse generator 60 supplies read control pulses which vary from −50 volts to inhibit readout, to −40 volts to enable readout. In a conventional pickup tube, the read control pulses vary from −150 volts to inhibit readout, to −50 volts to enable readout. As shown, the cathodes 36, 38, 40 are coupled to −45 volts.

FIG. 7 depicts another method and circuit for modifying the scanning process in accordance with the invention, wherein the image tubes of the prior circuits are replaced with solid state sensors 86, 88 and 90. In this system, the prior switch 42 comprises generally conventional horizontal and vertical scan drive circuit 92. Readout is controlled by interrupting the horizontal or vertical, or both horizontal and vertical, scan drive signals to inhibit readout during the N frames, and enable readout during the (N+1) frame. The H and V scan drive 92 is coupled to the read pulse generator 60, and is controlled by the read control pulses on line 63.

Although there are various schemes for controlling the readout process as described herein, control of the cathode potential as in FIG. 3 is advantageous since such scheme allows the tube or sensor to read out, and thus suppress, highlights in the scene. That is, if a highlight has a sufficiently high light level to develop greater than 10 volts of charge on the target, it will be read out continually during the scanning process. This prevents excessive light from a street lamp, flashlight, etc., from spoiling pictures which otherwise would be obtainable using the low light level techniques described herein.

Several limiting factors exist in the present system. For example, dark currents are generated in the photosensitive layer of the target. Also stray light from the tube's heater filament may impinge the rear of the target. Further, integration of light over too long a time period may cause excessive blur in the pictures if there is any movement in the scene being viewed. The first two effects may be offset by cancellation techniques

generally known in the art. Further, the dark current may be reduced by using a lower target voltage, and filament light leakage may be eliminated by employing relatively simple optical techniques to block the light. Excessive blurring is minimized by using values of N which are as small as possible, consistent with amount of reduced light available at the scene.

Although the invention combination has been described herein with respect to color television cameras, associated video storage apparatus and the field of color video in general, it is to be understood that the techniques and circuits are useful in any application or field wherein objects, images, etc., are viewed, scanned, etc., by means of, for example, optoelectrical transducers or sensors, whether tube or solid state, which are capable of being activated and inactivated, or otherwise controlled to allow selection of the amount of light which is collected prior to readout of a representative signal. Likewise, the storage means 54 may be any device capable of storing the information corresponding to the generated signal, and of selectively retrieving the information as desired; e.g., a tape or disk recorder/reproducer, a monolithic memory, i.e., frame or picture store or delay device, etc. Further, the invention may be used in cameras with any number of tubes, or which employ solid state image sensors rather than tubes.

What is claimed is:

1. System for increasing the effective sensitivity of an image tube during its readout scanning process, including means for inhibiting the image tube's readout scanning process for a selected plurality of inhibited scan periods of a given repeating cycle of scan periods, and for enabling the image tube's readout scanning process for a selected enabled scan period to generate a corresponding image tube output signal, comprising:

recorder means including a videotape recorder for storing the output signal as successive pictures during the enabled scan period; and

means integral with the videotape recorder for reproducing each successive picture in a still frame mode of operation during respective inhibited scan periods following each enabled scan period.

2. System for generating an optimized picture under very low ambient light conditions, the system including means for the readout scanning of a photosensitive surface, and means for enabling the means for the readout scanning of the photosensitive surface for an enabled scan period out of a selected cycle of scan periods, comprising:

read pulse generator means for generating readout control pulses to initiate the enabled scan period, wherein the absence of readout control pulses from the read pulse generator means inhibits the means for the readout scanning of the photosensitive surface;

solid state image sensor means defining said photosensitive surface;

scan means integral with the means for the readout scanning, for generating a horizontal and vertical scan raster on the solid state image sensor means photosensitive surface; and

wherein readout scanning of the photosensitive surface occurs during the enabled scan period.

3. A circuit for optimizing the effective sensitivity of an image tube having a repeating cycle of scan periods, comprising:

a cathode element;

source means for providing reference sync pulses at a rate corresponding to a television frame rate;

read pulse generator means coupled to the source means for selectively supplying to the cathode element readout control pulses having a potential sufficient to enable readout only for a selected scan period of the repeating cycle of scan periods;

processor means coupled to the tube for receiving a signal therefrom in response to the readout control pulses having said sufficient potential and for providing a corresponding interrupted output signal; and

recorder/reproducer means coupled to the processor means for selectively storing the interrupted output signal and for selectively reproducing the previously stored interrupted output signal to define a corresponding succession of still pictures.

4. The system of claim 3 wherein the recorder/reproducer means include frame store means for storing the interrupted output signal as one frame of information, and for selective reproduction of the one frame during the repeating cycle of scan periods wherein the readout control pulses do not have a potential sufficient to enable readout.

5. The system of claim 3 further including:

means coupled to said processor means for generating a flag timing pulse indicative of the occurrence of the readout control pulses; and

wherein said recorder/reproducer automatically is responsive to the flag timing pulse to selectively store the interrupted output signal.

6. The circuit of claim 3 wherein the read pulse generator means supplies the readout control pulses as a cathode potential of the order of −35 to −45 volts during the selected scan period of the repeating cycle of scan periods.

7. The circuit of claim 3 wherein the read pulse generator means includes;

frequency control means for determining the frequency of the readout control pulses commensurate with a selected range of numbers of the order of from 2 through 90 representative of the repeating cycle of scan periods; and

counter means coupled to the source means and responsive to the frequency control means to generate the readout control pulses.

8. A method for increasing the effective sensitivity of an image tube during a readout scanning process, comprising;

inhibiting the readout scanning process of the tube for a selected plurality of inhibited scan periods;

allowing the integration within the tube of incoming light during the plurality of inhibited scan periods;

enabling the readout scanning process for an enabled scan period following the inhibited scan periods;

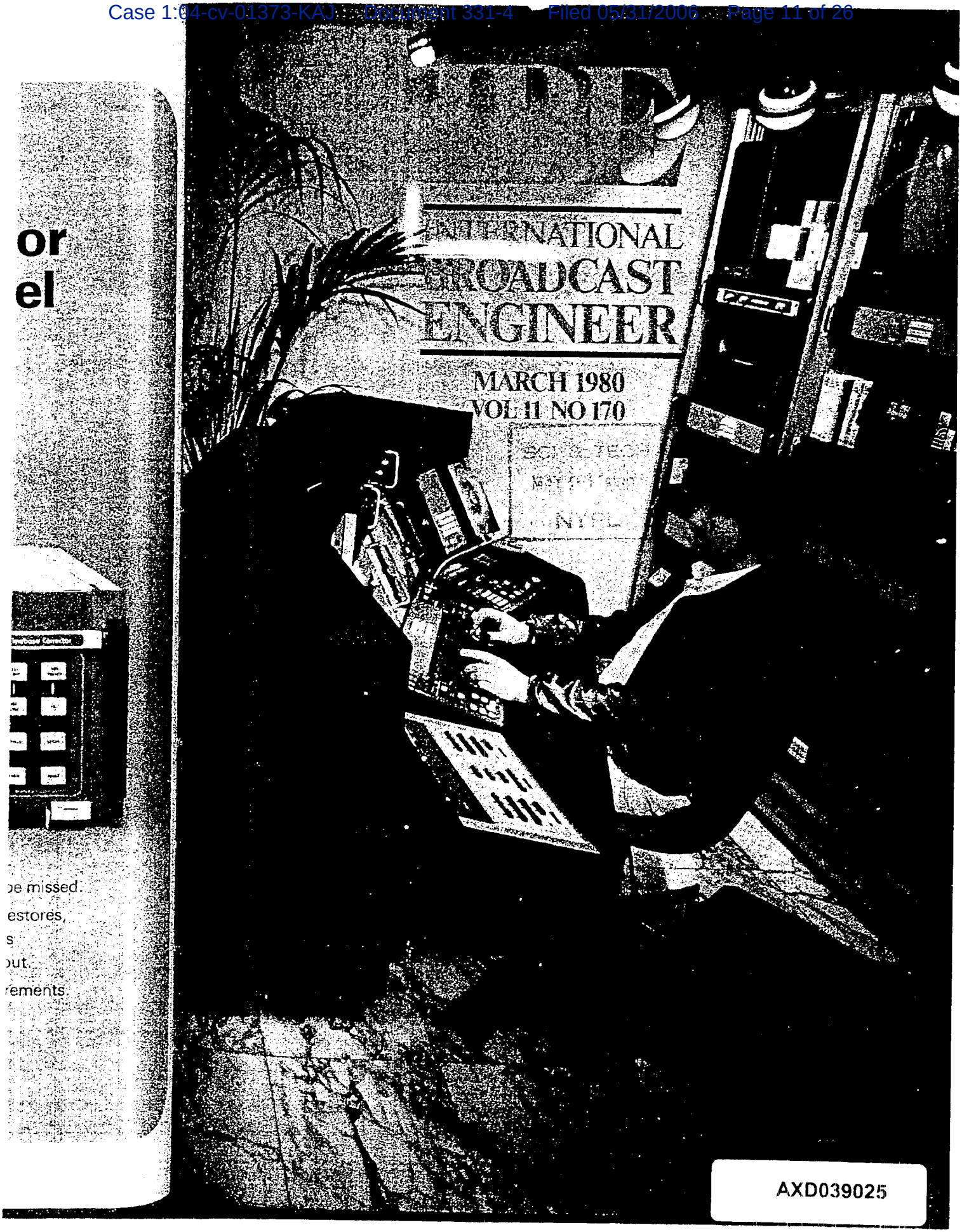
the step of enabling further comprising controlling the tube's cathode potential to allow readout thereof as an enabled signal only during the enabled scan period;

storing the enabled signal during the enabled scan period; and

reproducing the enabled signal during the inhibited scan periods to define a succession of still pictures.

* * * * *

EXHIBIT 12



or
el

be missed.
estores,
s
out.
rements.

AXD039025

IBE INTERNATIONAL BROADCAST ENGINEER

Volume 11 No 170 March 1980

Front Cover

The custom designed telecine control console of one of the most up-to-date facilities houses outside the USA, Europe Video in Amsterdam. The Rank Cintel Mk III is being operated by Brian Thomas. An article describing their operation will appear in a future Issue of IBE' (photo: Piet van Leeuwen, Haarlem)

Next Issue

The May issue of IBE will include a full report on the NAB convention together with equipment features on Magnetic Tape for professional One Inch VTRs and Video Prompting Systems.

Publisher — Derrick H. Baker
Editor — David Sparks
Group Advertisement Director — John G. Newman
Advertisement Manager — Peter Garland
Circulation Manager — M. Freeman
Production — Marion Newson/David Stubbs/Jay Bartlett

Overseas Agents:
France and Belgium — Marie Helene Causse, 26 Rue Duvivier 75007 PARIS, Tel: 555.63.43;
Italy — Milano, Via Col Moschin, 10. Tel: 8373363

INTERNATIONAL BROADCAST ENGINEER is printed and published bi-monthly in the UK by Whitton Press Ltd. It is available on subscription at £16 (sterling area) or US $35 per annum.

Whitton Press Ltd
All departments: 50 High Street, Eton, Berks England SL4 6BL
Tel: Windsor 62515/53841
Telex: 912881 — for Whitton

 ISSN 0020-6229

The DLS 6000

-A New Digital Still Store Library System

by Hugh Boyd, Quantel.

The Quantel DLS 6000 Digital Library System was first introduced to broadcasters at private demonstrations held during last year's NAB and Montreux exhibitions. At that time, the product was still under development, and Quantel were seeking comments from their invited guests as to the final configuration of the DLS 6000. The proferred advice was considered sufficiently valuable by Quantel engineers for some of it to be included in the ultimate system design, which will be demonstrated publicly for the first time at NAB 1980.

The DLS 6000 represents a new generation of still stores for television broadcasting. The system provides not only significant improvements in basic performance over existing techniques, it also offers several unique facilities that make the unit a complete production tool. At only 10.5 inches high for the DLS 6000, and 7 inches high for the storage disc unit, the system is ideally suited for OB van use as well as in the studio.

The Digital Library System is a naturally evolutionary product to come from the Quantel stable. It is revolutionary in concept and is based on a solidly engineered, flexible piece of hardware utilising three framestores and a DEC LSI-11 minicomputer. Typically, the DLS 6000 embodies

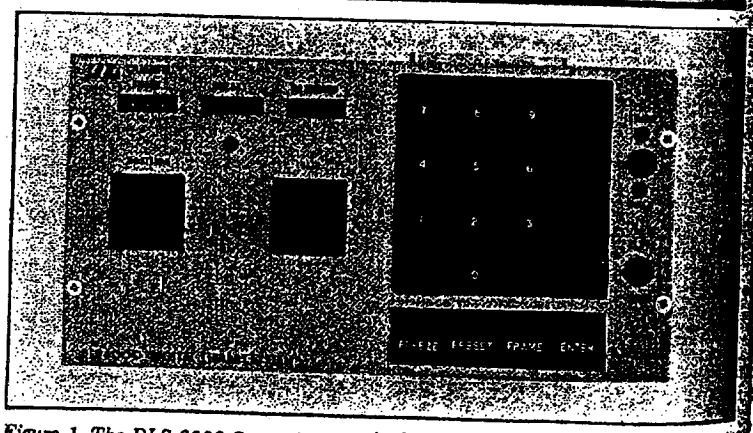


Figure 1. The DLS 6000 Control Panel

Quantel's basic principle of expandability by retrofitting new options as they become available. The word "obsolete" does not exist in the Quantel vocabulary!

Infinite Storage Capacity

The disc unit has a picture capacity of up to 340 stills. With multiple disc operation, say ten discs, 3400 pictures would be randomly accessible. However, the number of discs allowed is wisely unlimited, but is is anticipated that broadcasters requiring very large library storage will avail themselves of a video tape back-up store — a unique feature of the DLS 6000. Because the data is transferred in digital form there is no loss of quality. Picture information can be transferred automatically from disc to a standard video cassette or reel-to-reel machine without it being modified, whether it is in use in a studio or OB van.

Transfers from tape to disc work in exactly the same way, therefore a cassette is all that is required to move information between locations. Similarly, a full archival store library can be formed from cassette or tape with more than 3000 pictures being stored on one tape. Again, being digital in format, no generation losses are seen no matter how many times the information is recorded or re-recorded.

Production Effects Ca

The provision of a nu duction effects seems t facility for a Quantel based product. The DL this integral feature for reasons.

Picture repositioning is the simple movement of the compact 8" x 4" (Figure 1).

Picture compression is by moving a joystick. image may be reduced between normal (full virtually zero size. This used with repositioning, exact size and positio without employing any effects system.

Picture enlargement. Jo ment enlarges the imag times to allow selection portion of a still.

Variable aspect ratio. ratio of the image can b the normal 4 x 3 to an shape.

Multiple picture handlin 6000 is capable of re many pictures as are w same time. This facility adjunct to compression tioning. It is used either the same time, a numbe pants in a discussion or e to build up a complete images. The pictures ca down from the disc one show the viewer the buil be called simultaneously the finished composite Borders. The DLS 6000 with its own border gene of changes in hue, satur ance and width. Borders c around all pictures beir desired, although differen have quite different borde at the same time. The bor also includes a backgrou generator, further releasin for other functions.

Extensive Operating Fe

Both the technical direc system operator were kep in mind by Quantel wh the Digital Library Syste a computer display pane director's being associate

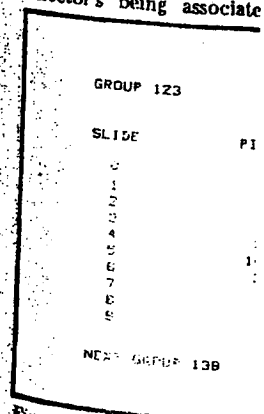
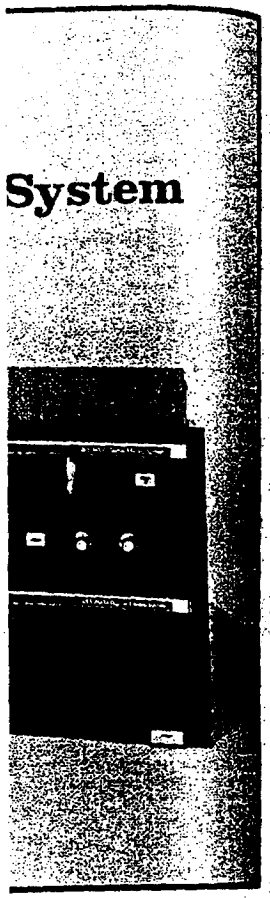
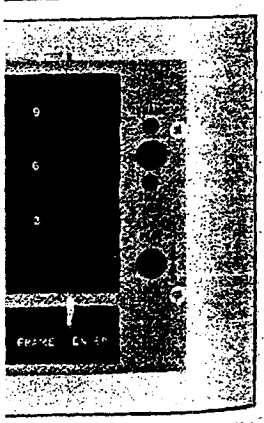


Figure 2. An example of





the DLS 6000. Because the
ansferred in digital form,
o loss of quality. Picture
n can be transferred auto-
rom disc to a standard video
reel-to-reel machine without
odified, whether it is in use
or OB van.
sfers from tape to disc work
the same way, therefore a
all that is required to move
n between locations. Simi-
ll archival store library can
from cassette or tape with
3000 pictures being stored
pe. Again, being digital in
) generation losses are seen
how many times the infor-
ecorded or re-recorded.

Production Effects Capability

The provision of a number of production effects seems to be a logical facility for a Quantel framestore-based product. The DLS 6000 has this integral feature for very practical reasons.

Picture repositioning is achieved by the simple movement of a joystick on the compact 8" x 4" control panel (Figure 1).

Picture compression is also achieved by moving a joystick. The stored image may be reduced to any size between normal (full frame) and virtually zero size. This feature, when used with repositioning, defines the exact size and position of a still without employing any other digital effects system.

Picture enlargement. Joystick movement enlarges the image up to two times to allow selection of a chosen portion of a still.

Variable aspect ratio. The aspect ratio of the image can be varied from the normal 4 x 3 to any rectangular shape.

Multiple picture handling. The DLS 6000 is capable of reproducing as many pictures as are wanted at the same time. This facility is clearly an adjunct to compression and repositioning. It is used either to show, at the same time, a number of participants in a discussion or event, or even to build up a complete montage of images. The pictures can be called down from the disc one at a time to show the viewer the build up, or can be called simultaneously so that only the finished composite is broadcast.

Borders. The DLS 6000 is equipped with its own border generator capable of changes in hue, saturation, luminance and width. Borders can be placed around all pictures being shown if desired, although different images can have quite different border parameters at the same time. The border generator also includes a background or matte generator, further releasing the mixer for other functions.

Extensive Operating Features

Both the technical director and the system operator were kept very much in mind by Quantel when designing the Digital Library System. Each has a computer display panel, with the director's being associated with the mixer and almost always used for replay. Whereas, the panel the operator (or "composer") uses, will be essentially employed for recording. The DLS 6000 is capable of single or two person operation, so two control panels may access the machine simultaneously for *time sharing*.

High change rate. Pictures can be changed at a rate of two per second with complete random access. Thus, no cache memory of the day's programme requirement has to be prepared.

On-air picture change. Although the change rate is limited to two per second, the additional framestore circuitry in the DLS 6000 allows vertical interval switching between pictures. The switch is instantaneous: only the throughput rate is limited to two per second.

On-air transitions. When using the DLS 6000, a mix/effect bus can be eliminated by utilising the digital transitions available in the unit. Changes between one picture and the next can be by means of a simple cut, a programmable dissolve, or even a wipe.

Multiple outputs. Three outputs are available with the DLS 6000 — two programme and one preview. Internally generated transitions are possible with both programme outputs, or they can be used together to utilise more exotic wipes in a mixer. Keys are generated by the system to match the picture at all times.

Preview. The DLS 6000 has its own preview output which can be operated without affecting the on-air programme or transitions. The preview allows the varying sizes or positions of images to be chosen by means of cross wires controlled by joysticks, and also contains the fast viewing or "browse" feature.

Browse. The preview facility has the ability to look through the contents of the disc by displaying 25 images at a time, and slowly moving them down the screen. This rolling list of pictures allows easy viewing to find a desired frame, or alternatively, permits the showing of pre-chosen slides waiting in the "stack" for display during a programme.

On-air editing. As previously mentioned, the on-air display or transition is unaffected by previewing. Similarly, the DLS 6000 permits the capture and recording of incoming material while the equipment is being used during a broadcast. This is an essential feature to get the full benefit of the system in a news studio situation.

Asynchronous operation. The input of the Digital Library System can handle asynchronous information to allow stills to be captured from incoming ENG material.

Graphics handling. The DLS 6000 is capable of keying stored graphics over displayed images, thereby releasing the mixer from this function. Graphics may have their size and position defined quite independently of picture information, always assuring perfect readability for all sizes of titled images.

Digital re-recording of composite pictures. Composite pictures created on the preview monitor can either be stored as control parameters to ensure recall on demand on the programme outputs, or alternatively, can be re-recorded back onto disc as a complete new picture at an individual location.

Editing system. Complete sequences of commands to the DLS 6000 can be set up and stored for simple single button operation during a programme. The editing system does, however, allow simple addition or deletion of items to ensure ease of operation in a fast moving news broadcast. The minicomputer in the system will permit the addition of standard computer peripherals at a later date to accommodate even more powerful editing equipment.

Control delegation. As previously stated, the control of the DLS 6000 can be time-shared between several stations including during a live broadcast. Separate preparation and replay panels permit the technical director to remain divorced from the recording of stills from incoming ENG material.

Obviously, the basic task of the Digital Library System is to replay the correct picture from the disc store. However, the usefulness of the system is greatly enhanced by the ability to choose the size and position of the replayed picture, and to define it in accordance with the requirements of the rest of a production. The Quantel tradition of high fidelity is maintained in the quality of the images produced by the DLS 6000 at all times, whether the size of the still has been modified or not. At all sizes and shapes, the unit displays excellent image quality, with-

GROUP 123

SLIDE	PICTURE	SIZE & POSITION	BORDER	TRANSITION	CUE
0	23	NORMAL	ON	DISSOLVE	20
1	18	COMPRESS	OFF	CUT	
2	14	ENLARGE		WIPE	10
3					
4	38	COMPRESS		SUPER	INSTANT
5	100	COMPRESS		SUPER	
6	23	COMPRESS		CUT	
7					
8	11	NORMAL		CUT	EXT
9	10				

NEXT GROUP 138

Figure 2. An example of a typical Edit Display (as would appear on the TV monitor).

out showing any hint that the video has been processed.

The Control System

The philosophy behind the control system for the Digital Library System is based on the concept of Pictures, Slides and Groups. A Picture is defined as an image on disc and has a number allocated to it at the time of recording. Pictures are normally recorded on disc at full size to give maximum flexibility on replay. A Slide is a Picture on replay that has the parameters of size, position, transition type and time, etc, allocated to it. The number of a Slide need not be the same as the number of the Picture that the Slide depicts. A Group is a collection of up to ten Slides.

It is essential to appreciate that, with this machine, defining a still merely by a number is insufficient due to the extra facilities available. Therefore, both the still and what is to be done with it must be defined before displaying on the programme output. The computer display. The extra degree of freedom made available by the DLS 6000 production features, make it necessary that at both preparation time and programme time, the operator always has a clear picture of exact machine status. In order to give the user this clear indication of the situation, a video display system has been added to the host computer, and it is via this display system that all setting of parameters is achieved.

The computer display output is added to the preview output, and hence, shares the preview screen. There are three types of computer display available to the user: Edit, Ident and Menu. A cursor display is added to all these to allow the size and shape of images to be defined on the preview monitor.

A Typical example of the Edit display is shown in Figure 2. It will be seen that the Slide number is independent of the Picture number as has been described earlier.

The Ident display overlays the true Picture number when using the "browse" feature, so that the various chosen Pictures may be easily identified.

The Menu display is a special option that allows selection of modes of use of the machine, and it is this display that is used in conjunction with the tape backing store system.

The recording chain is shown at the top of Figure 3. Input video enters the system and is immediately converted into digital format and passed to a framestore at full video data-rate. This input framestore acts as a freeze frame device and allows the user to select still pictures from the incoming live video. For simplicity, the link from the output of this store to the preview output from the DLS 6000 has not been shown, but in reality, the video follows this path allowing the user to observe the incoming picture at all times, whether live or frozen.

Once the chosen image has been frozen in the framestore it is read out from the store at disc rate via a data processor section to further reduce data rates, and then via the disc formatter to block the information suitable for writing onto the disc.

The disc itself is a latest generation Winchester drive high packing density sealed unit. The heads are of the flying type, but the construction of the disc eliminates the need to have expensive and unreliable head retraction mechanism — the heads actually land on the disc surface when the platter is not in motion. The disc data rate allows a picture to be generated in 0.5 seconds. The total package is highly reliable and rugged and includes parity check circuitry for optimum data integrity.

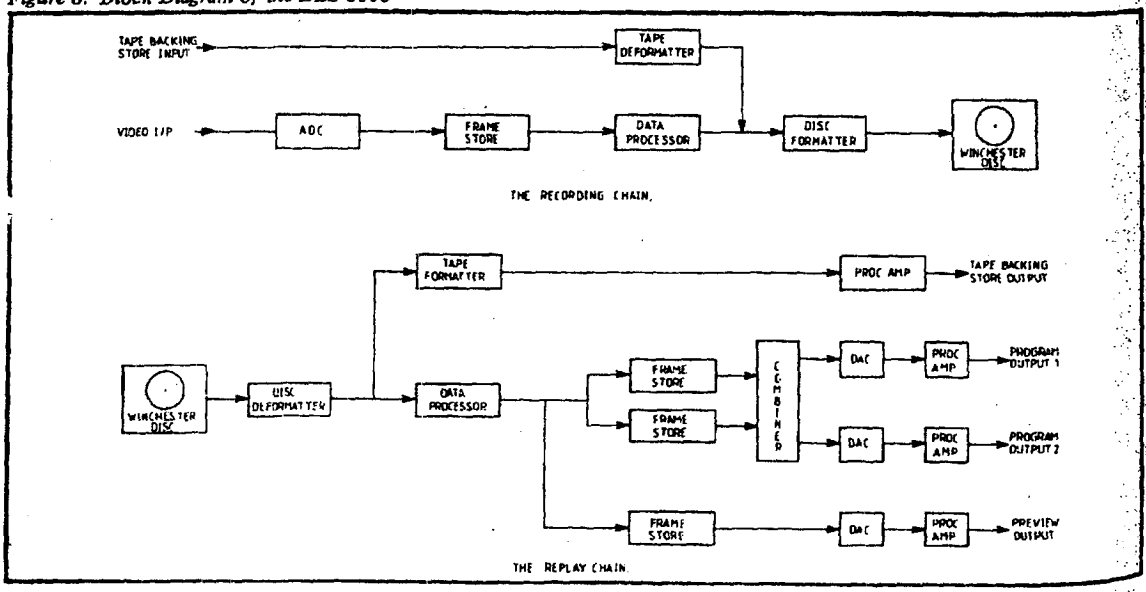
The replay chain, shown at the bottom of Figure 3, is obviously more complex than record due to the increased number of framestores and programme output facilitites. Data from the disc passes through a disc re-formatter where the information is sorted out from its blocks, and then onto the data processor where it is unpacked. At this point, the information is passed to one of the three framestores available, and it is now that the size change mechanism operates. If the information is routed via the preview store, no other processing is done other than reading it out of the store at full video rate into a DAC and onto the display via a proc amp. If the data is fed to one of the programme stores, it is subsequently passed to a digital combiner assembly that performs the appropriate wipe, cut or dissolve functions. Also, the combiner copes with the addition of borders or the keying of caption information over pictures or coloured matte.

For convenience, one framestore is shared between the video input facility and the preview output. Not shown in Figure 3 is the host DEC LSI-11 minicomputer that controls the whole machine and is responsible for all housekeeping tasks, the operation of the control panel and the editing system.

The tape backing store system is interfaced to the disc before and after the disc formatter and de-formatter. The information on disc has to be prepared and re-blocked by the tape formatter prior to the addition of sync and burst for feeding to the tape system. It should be remembered that the tape system is perfectly conventional, and can be any recorder available in the studio or OB van.

When receiving information from the tape backing store, information is unpacked and blocked in a tape de-formatter before being passed on to the disc. The DLC 6000 Digital Library System is available in NTSC standard. But, as usual with Quantel, it is reasonable to assume that PAL and SECAM versions are already being developed. When they are introduced, one can expect even more flexible facilities to be unveiled, and naturally, none of them will make any other part of the existing system obsolete. ■

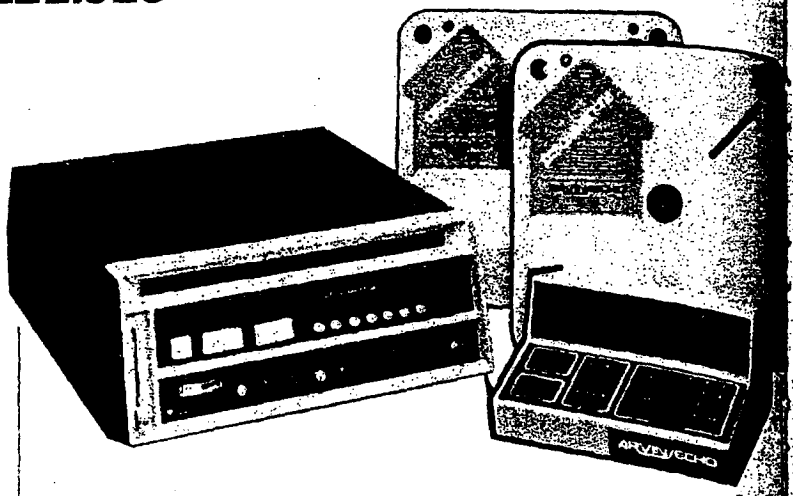
Figure 3. Block Diagram of the DLS 6000



STILL STORES

Video Frame Storage Using Flexible Magnetic Discs

by John Romanko,
Arvin/Echo



Arvin/Echo, a leader in Frame Storage on a flexible disc, has manufactured over 600 systems in the past four years and has had the Pal/Secam disc recorders for the past three years. These devices are now being used in greater numbers throughout the world.

The following article will introduce and describe the technology used by Arvin/Echo to produce the EFS-1A P/S (Pal/Secam).

Storage Medium — The Discassette

The Discassette has a housing of aluminium covers for ease of handling, and for protection of the flexible discs inside. Two circular 32.38 cm sheets of high density video tape such as the type used in the new type 'C' format high band recorders, form the upper and lower recording surfaces. These discs are separated by a compliant spacer of the same diameter; all three layers are fastened at the center to a hub, which engages the disc drive in the recorder. When operating, the disc rotates within the covers at 1500 rpm in synchronization with reference video (1 revolution per video frame). The covers are slotted on both sides to allow the head to contact the rotating disc surfaces.

Recording Head

The Arvin/Echo video disc recorders employ hot pressed Mn-Zn Ferrite heads with glass bonded gaps. Each head consists of an erase transducer and a slightly narrower record/playback transducer in tandem, which enables a track and its guardband to be erased and the track to be re-recorded in a single pass. The transducers are bonded to a lightweight aluminium block which is bored through to engage a mounting pin in the head suspension mechanism. A multi-conductor flexible lead and connector plug into the record driver/playback preamplifier.

Head Suspension

Mounted on its suspension pin, the head is spring-loaded against the disc by a force of several grams, and is allowed to follow disc surface run-out in the direction perpendicular to the plane of the disc. Adjustments are provided to align the head to the pre-recorded tracks of a master alignment disc.

A solenoid-operated head lifter disengages the head from the disc when it is off or in the standby mode.

The head-to-disc interface is of critical importance in controlling track life, head life, video signal/noise ratio, and timebase error. Considerable effort has been directed to the selection of head materials, head geometry, disc surface conditions, and loading forces to optimize head/disc contact for maximum performance with minimum wear. Head life of 1500 hours, and track life of 10 hours (in freeze frame on a single track) are typical of what can be expected under reasonable environmental conditions.

Head Positioning

The head and its suspension are mounted on a moveable carriage which steps the head radially in one-track increments with respect to the disc, allowing the head to record and playback a succession of concentric circular tracks. The carriage is moved by a 90° stepper motor and a lead screw and is equipped with an anti-backlash mechanism. The guardband required between tracks is determined by (1) head positioning errors, (2) disc centering errors (if the disc is removed and replaced) and (3) disc expansion/contraction relative to the recorder structure. It has been determined that .0762 mm guard bands are required for disc interchangeability (machine to machine) and .0381 mm guard bands for disc replaceability.

Disc Drive

The disc is driven by a servo-controlled DC printed circuit motor, phase locked to horizontal and vertical reference sync. The drive motor engages the disc by a centering mechanism which insures that the center of disc rotation is independent of mechanical tolerances in the disc hub or drive hub. A slow-start circuit in the drive servo limits start-up torque so that the disc material is not overstressed. Once up to speed, the disc forms a stiff plane under the influence of rotational and aerodynamic forces.

Video Signal Processing

The colour video signal is recorded directly in FM format, using lowband carrier frequences, deviation, and pre-emphasis. Writing speeds vary typically from 1978 cms at the inner track to 2393 cms at the outer track. Playback equalisation is varied by means of a mechanical linkage to the stepper assembly so as to hold the video frequency repose constant as writing speed varies.

Timebase error is in the order of 400 ns to 1 usec p-p, necessitating the use of timebase correction or other processing for colour recovery.

Several advantages of flexible discs may be noted in comparison to rigid discs:

1. Disc is in a cassette form for ease of handling and storage.
2. Disc is removeable, replaceable, interchangeable.
3. Low disc mass requires low drive power.
4. The discs are highly cost effective due to the relatively inexpensive materials and processing used in their construction.
5. Resistant to vibration, shock and contaminants.
6. Lower separation losses in contact recording permit higher packing densities, and better signal/noise ratio.

These factors make for compact, low power, system designs capable of high performance and reliability under severe environmental conditions.

EFS-1A P/S Description

The EFS-1A P/S Discassette Frame Store Recorder is a compact, portable electronic slide station, with an on-line capacity of 100 images on each side of the disc. The cassettes are conveniently slot loaded at the front of the unit and may be recorded on one machine and played back on another.

Front panel pushbuttons for record and playback tracks, as well as variab sequencing in either th reverse directions.

A remote control a the RC-100, allows the control functions to be r 150 feet, and in additic numerical keyboard for r of any of the 100 ima Special interface adapters for the remote control allows track addresses t from external sources ot keyboard, such as a digi (ASC II Code) or a charac keyboard.

Block Diagram

The disc drive and stepper are powered by MDAs l power supply. The disc s horizontal lock by con frequency tach pulses fro shaft with horizontal re pulses. The vertical inde vertical framing by comp around pulse from the di a frame pulse derived fr sync.

The FM signal fror lator is fed to the re playback preamplifier wh record current and erase c dual gap head. The pla from the record driver/p amplifier is equalized playback losses and inclu sation for variations in wri

In the PAL/SECAM cessor, the video outpu demodulator is constructe frame PAL or a two fra sequence from a single rec

Briefly, for PAL, th cessor separates chroma demodulated video and delays the chroma by on other frame. Additionally inverted 180° at a two rate (two frames inverted, not inverted). The playb four frame PAL sequence i

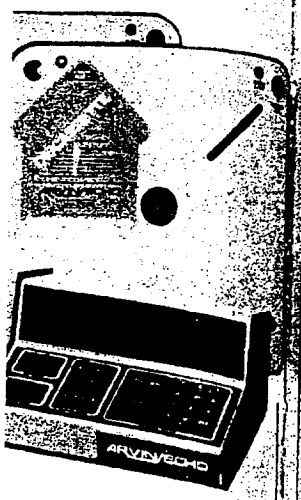
1st frame — No one-lin chroma inverter.
2nd frame — One-line chroma inverter.
3rd frame — No one-line de inverter.
4th frame — One-line delay inverter.
5th frame — No one-lin chroma inverter.

The operation in SE same except that the chrc is disabled.

Applications

Applications and uses of P/S are continually expanc broadcast and other areas.

TV broadcast and applications include sport news, special events, var and station breaks. No applications include slo transmission, teleconferen cal imaging (X-Ray, ultra nuclear), electron microsc naissance, instrumentation, image processing.



gnal Processing

ır video signal is recorded
› FM format, using lowband
quences, deviation, and pre-
Writing speeds vary typically
8 cms at the inner track to
at the outer track. Playback
on is varied by means of a
l linkage to the stepper
so as to hold the video fre-
epose constant as writing
es.
ebase error is in the order of
1 usec p-p, necessitating the
mebase correction or other
for colour recovery.
eral advantages of flexible
be noted in comparison to

in a cassette form for ease of
ıg and storage.
s removeable, replaceable,
angeable.
ilisc mass requires low drive

scs are highly cost effective
› the relatively inexpensive
ils and processing used in
onstruction.
nt to vibration, shock and
inants.
separation losses in contact
ng permit higher packing
es, and better signal/noise

se factors make for compact,
r, system designs capable of
ormance and reliability under
ironmental conditions.

P/S Description

-1A P/S Discassette Frame-
order is a compact, portable
slide station, with an on-line
of 100 images on each side of
The cassettes are conven-
t loaded at the front of the
may be recorded on one
and played back on another.

Front panel pushbuttons are provided for record and playback of individual tracks, as well as variable rate image sequencing in either the forward or reverse directions.

A remote control accessory unit, the RC-100, allows the front panel control functions to be remoted up to 150 feet, and in addition provides a numerical keyboard for random access of any of the 100 images on line. Special interface adapters are available for the remote control unit which allows track addresses to be entered from external sources other than the keyboard, such as a digital computer (ASC II Code) or a character generator keyboard.

Block Diagram

The disc drive and stepper drive motors are powered by MDAs located in the power supply. The disc servo provides horizontal lock by comparing high frequency tach pulses from the motor shaft with horizontal reference sync pulses. The vertical indexer provides vertical framing by comparing a once-around pulse from the disc shaft with a frame pulse derived from reference sync.

The FM signal from the modulator is fed to the record driver/playback preamplifier which provides record current and erase current to the dual gap head. The playback signal from the record driver/playback preamplifier is equalized for record/playback losses and includes compensation for variations in writing speed.

In the PAL/SECAM colour processor, the video output from the demodulator is constructed into a four frame PAL or a two frame SECAM sequence from a single recorded frame.

Briefly, for PAL, the colour processor separates chroma from the demodulated video and alternately delays the chroma by one line every other frame. Additionally, chroma is inverted 180° at a two frame toggle rate (two frames inverted, two frames not inverted). The playback of the four frame PAL sequence is as follows:
1st frame — No one-line delay. No chroma inverter.
2nd frame — One-line delay plus chroma inverter.
3rd frame — No one-line delay. Chroma inverter.
4th frame — One-line delay. No chroma inverter.
5th frame — No one-line delay. No chroma inverter.

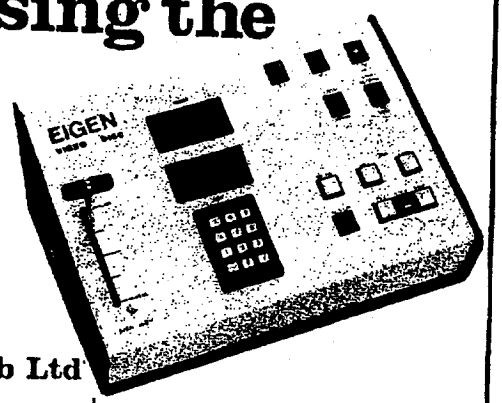
The operation in SECAM is the same except that the chroma inverter is disabled.

Applications

Applications and uses of the EFS-1A P/S are continually expanding in both broadcast and other areas.

TV broadcast and production applications include sports, weather, news, special events, variety shows and station breaks. Non-broadcast applications include slow-scan TV transmission, teleconferencing, medical imaging (X-Ray, ultrasound, and nuclear), electron microscopy, reconnaissance, instrumentation, and digital image processing. ■

Electronic Slide Store Using the Eigen Video Disc Drive



by Simon Hill,
Prostab Ltd

A new controller and other accessories are now available for the 6 MHz Eigen Video Disc Recorder, which makes the Slow Motion/Stop Field Frame suitable for Electronic Slide storage and display. The European Distributors for Eigen — Prostab International Ltd — have introduced a Colour Processor module which incorporates Chroma Correction and a Pal Transcoder, retimed to an integral Gen Lock, and this unit is mounted on the output of the disc. As well as correcting the unstable frequency components of the chrominance signals due to time base variations in the recorder, the transcoder gives a 3DB improvement in Chroma Signal/Noise ratio, and recreates Pal sequence and indentification when still fields or frames are to be displayed.

With this colour processor, the Eigen Recorder appears in a system as a High Band VTR, and is compatible with most Time Base Correctors where high quality colour performance is required.

The Slide Scanner controller allows individual frames, or fields to be loaded on to the disc either as continuous video, or as individual 'shots' and the simple controller utilises a keyboard to load the field/frame address. The slide address can be input in advance of selection, and a 'Go To' button institutes the search to the appropriate track or tracks. A particular feature of this system is that fields, rather than frames are stored on each track, so that, where an unacceptable level of interfield jitter is apparent, as in sports action for example, single field slides can be retrieved. These are fed on alternate revolutions of the disc through a half line delay, thus maintaining an apparent odd/even field sequence from a single field source. Another advantage of this system is the increased writing speed when compared with frame per rev. systems.

The slide writing facilities include a simple No Step record facility, which readily allows the store to be overwritten or updated if unwanted slides have been loaded. Although the controller has all the facilities necessary for a slide store, (worst case access time to any of 500 slides is 2 seconds) Eigen have maintained the usual slow motion analysis capabilities, so that the system is equally suitable for both purposes.

While primarily as a slide output device, its use in reverse mode as an animation device where single frames (cells) are loaded via a Rostrum Camera and replayed at any required animated rate, should also be of interest.

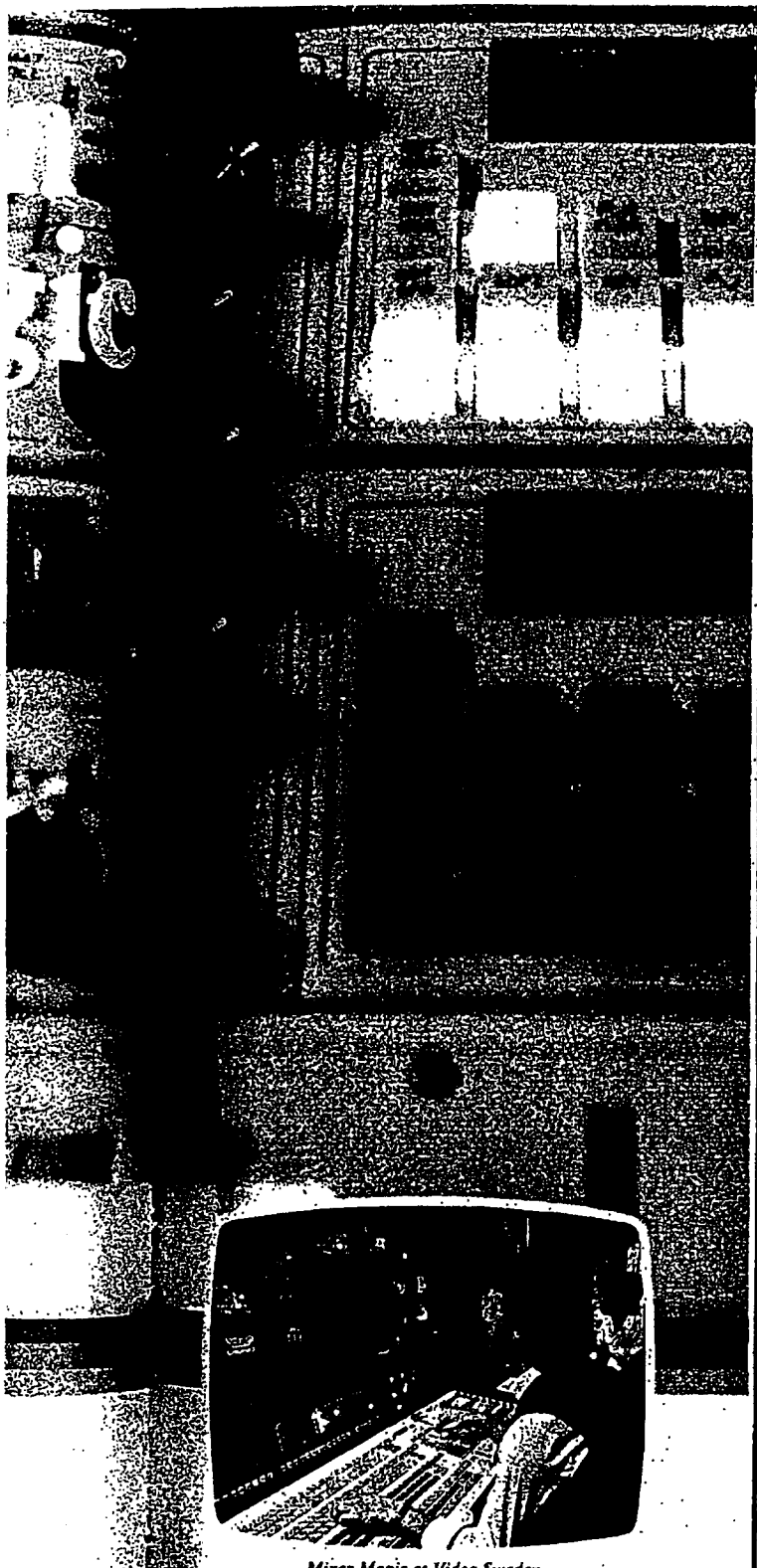
As in all Eigen Recorders the inexpensive cassette mounted disc can be exchanged in about 15 seconds and the recording/replay heads are fully located by twin dowels so that these too can be exchanged within a couple of minutes. Down time therefore is kept to a minimum.

Because the Eigen Disc utilises 2 heads on two steppers each of which can move to the next track and settle well within field time (20 milliseconds) it is possible to assemble a series of slides for a specific programme on to the disc, and to dump them on to a VTR for safe keeping. When these particular slides are required again, they are re-coded on to the disc as real time video and once the slide address counter has been zeroed again to slide 00, they can be reselected as a series of stills.

As well as a facility to respond to an external cue signal, which will initiate either single field/frame increment, animation of real time or predetermined slow motion, a full TTL interface is also available so that the system can be controlled by a remote computer based editing or switching console if required. Slide scanner control is available for the 17.10 ten second - 500 field disc store, and a 17.20 twenty second slow motion action replay device is also available.

To conclude, the Eigen Video Disc Store, complete with the new controller and colour processor, is a cost-effective and flexible system well suited for slow motion, electronic slide storage and display. ■

EXHIBIT 13



Mixer Magic at Video Sweden

Visit us on stand 705, see our new product and indulge yourself with a demonstration of true Grass Valley mixer magic.

IBE INTERNATIONAL BROADCAST ENGINEER

Volume 14 No 189 **May 1983**

Front Cover

Printed circuit boards from the new Horizon Routing Switcher launched by Grass Valley at NAB. (Photo courtesy of Grass Valley Group).

Next Issue

The September '83 issue of IBE will include a report on Montreux '83 together with an equipment feature on Telecines and Colour Correctors.

Editor	*David Sparks*
Advertisement Manager	*Peter Garland*
Circulation	*Jill Hosier*
Distribution	*David Martin*
Production	*Marian Newson*
	David Stubbs/Roger Warner

Whitton Press Ltd

Managing Director	*Derrick H. Baker*
Group Advertisement Director	*John G. Newman*
Production Manager	*Ray Robinson*

50, High Street, Eton
Berks, England SL4 6BL
Tel: Windsor (07535) 53756
Telex: 912881 – Eton

Overseas Agents: France & Belgium *Marie Helene Causse, Agence M.H.C. 20/22, Rue Valadon, 75007 PARIS, Tel: 555.63.43. Telex: 642 138 F MHC 171.* West Germany Postal Areas 2, 3, 4, 5, 6, *Werner Hagan, Verlagsburo, Postfach 180 134, 4000 Dusseldorf 13. Tel: 021171 8969.* Postal Areas 6,7, *Wolfgang Richter, Sudring 53, 7240 Horb/Neckar 1. Tel: 07451 7828.* Postal Area 8, *Gunther Maune, Postfach 255, 8939 Bad Worishofen. Tel: 08247 4107.* Italy *Ediconsult Internazionale SA, Piazza Fontane Marose 3, 16123 Genoa. Tel: 268334, Telex: 211197 EDINT I, Sales Dario Calabrese, Quartiere S. Felice, 8A Strada, 14, 1-20090 Segrate, Milan. Tel: 753 0274.*

INTERNATIONAL BROADCAST ENGINEER is printed and published bi-monthly in the UK by Whitton Press Ltd (a member of the Argus Press Group). It is available on subscription at £24 sterling (excl) or US $60 per annum.

Second Class postage paid at New York, N.Y. US Mailing Agents Expeditors of the Printed Word Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022.

INTERNATIONAL BROADCAST ENGINEER is an independent journal devoted to the design, manufacture and operation of professional television and radio broadcast equipment. Opinions expressed in articles do not necessarily represent the view of the editor or publisher.

ISSN 0020-8229

'Slide File'

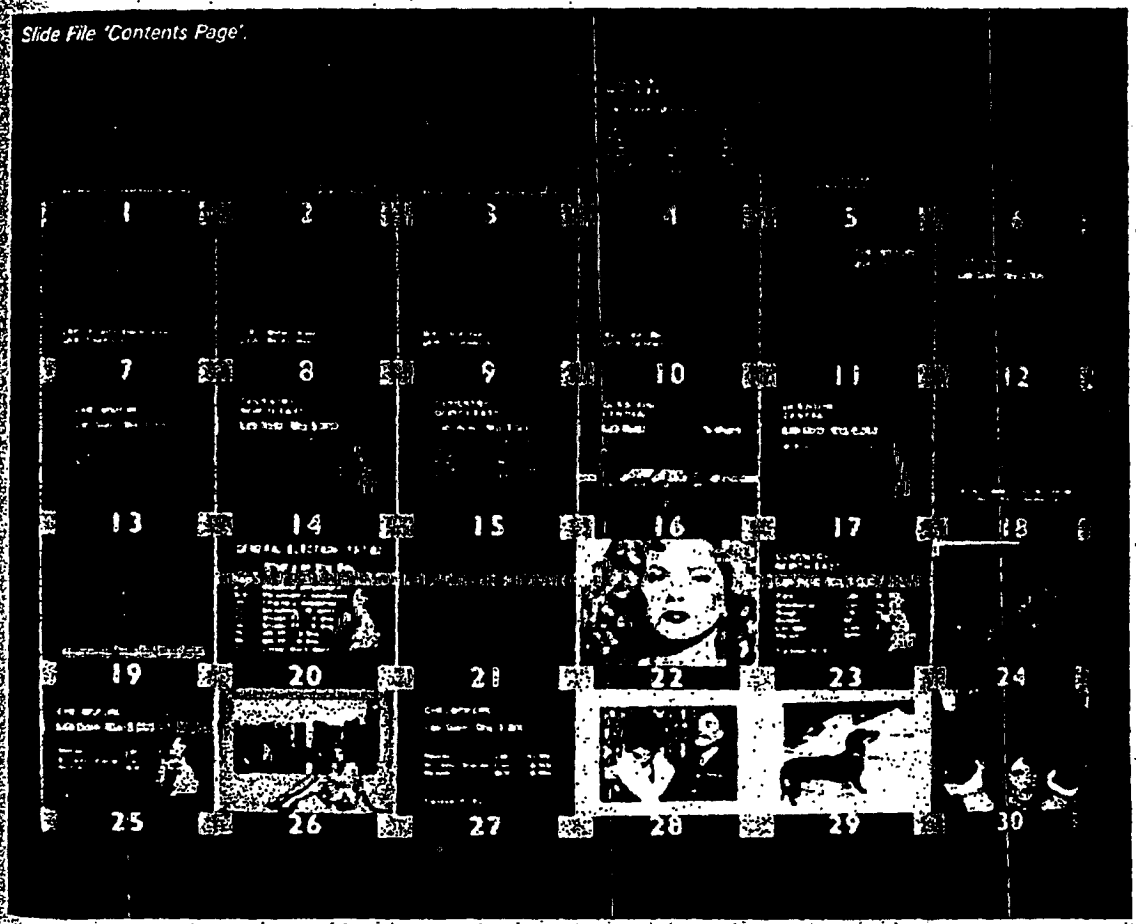
by Dennis Moralee,
Rank Cintel

As a result of the success of a number of pioneering in-house developments and first-generation commercial products, the concept of digital stills storage has now gained widespread acceptance. There can no longer be any doubt that digital stills storage offers many important advantages over more traditional approaches to stills presentation, and particularly over the use of conventional slide scanners using ordinary 35mm slides.

Unfortunately, with existing systems, these advantages of digital stills storage have undeniably been obtained only at the cost of losing much of the simplicity and operational convenience inherent in the more traditional approaches. The real problem has been that the cost constraints of digital technology have up to now meant that digital still stores could be cost effective only when used as centralised library units holding many thousands of slides and accessible from the individual studio or work area only through the use of rather inconvenient remote terminals. As a result, the advent of digital storage technology, although undoubtedly an important step forward, has seemed up to now to have unfortunately put an end to the straightforward approach to stills presentation in which each production team could have the convenience of its own portable and self-contained 'slides box', from which all the production's stills could be taken and presented as required, using a simple, standalone item of studio equipment no more difficult to operate and understand than an ordinary audio cassette recorder or VCR.

Fortunately, more recent advances in digital technology have now allowed these disadvantages of existing digital stills stores to be made a thing of the past. By providing the designers of digital stills store equipment with a new generation of low-cost, high-performance hardware, these technical advances have given them the freedom to design a digital stills store system, codenamed 'Slide File', that not only provides all the undisputed advantages of digital storage but also offers all the simplicity and operational convenience of traditional slide-based equipment. Developed initially by BBC research and now re-engineered as a commercial product by Rank Cintel Ltd, the resulting system is a low-cost, self-contained item of studio equipment with an on-line storage capacity realistically geared to the needs of individual productions and specifically designed for ease of operation by existing production staff. Indeed, with its use of convenient, pocket-sized tape cartridges for off-line storage, it brings to the stills-presentations side of video production exactly the same kind of flexibility and freedom that the audio cassette recorder has brought to the 'jingles' and sound-effects side of audio production.

Behind these advantages of the new Slide File design are important advances in four main areas of digital stills-store technology; semiconductor picture storage, on-line disc storage, off-line 'streaming' tape storage and software-based video enhancement. Perhaps the most influential single factor in its new design approach, however, is purely economic, reflecting the remarkable fall in the cost of semiconductor memory components that has occurred during the last year or so. With the large-scale introduction of the 64k bit RAM device has come not only the significant saving that can be expected to result from a four-fold increase in storage density, but also a new intensity of competition within the semiconductor industry that has driven memory prices down to un-



Slide File 'Contents Page'.

precedented levels. This remarkable fall in memory costs has, of course, led to a corresponding fall in the production costs of all memory-intensive electronics-based equipment, of which digital picture stores are an obvious example, but more importantly it has also given engineers a whole new freedom to redesign existing types of equipment to take full advantage of the lifting of former cost constraints. With Slide File, this new opportunity has been used to change the orientation of digital stills-store design away from the needs of the centralised stills library and towards the needs of the individual production team. This does not mean that Slide File is meant to remove the need for a centralised stills library, but that its designers recognise that the library function and production function, while complementary, have significantly different requirements.

To see how the cost constraints of producing digital picture stores have in the past influenced the design of digital stills-store equipment, it is first useful to review how any such equipment must operate (Figure 1). At the very heart of any digital stills-store system there must, of course, be at least one digital picture store to hold the complete video 'still'; and in most practical systems there will be at least two such stores to allow previewing, mixing between stills, etc.

At any one time, these frame stores hold the currently 'live' stills; the remainder held within the system are stored in an on-line disc store, between which and the picture stores individual stills can be exchanged as desired, under the control of the system's computer processor. For off-line storage, stills can also be exchanged between the picture stores and some removable storage medium; removable disc packs, tape reels, video cassettes or, as in the case of Slide File, the new-generation 'streaming' tape medium. As well as controlling the exchange of stills between these various storage media, the system's computer processor also carries out a number of other functions, including fading, wiping, cutting and mixing between stills in the picture stores, and possibly the digital manipulation of the video information in the picture stores for a variety of image-processing applications.

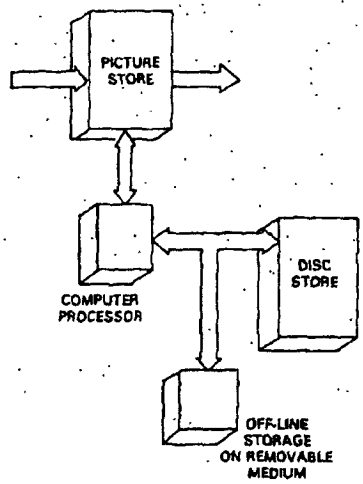


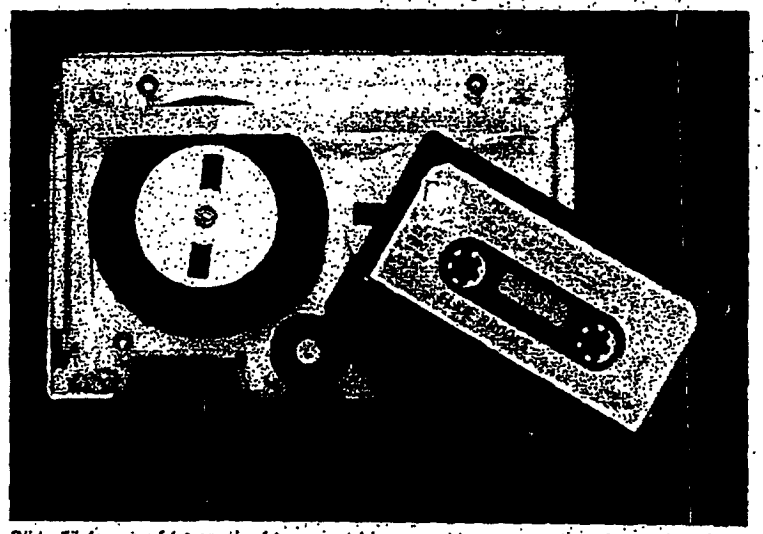
Figure 1. Digital stills storage. Basic functional units.

In existing digital stills-store designs, the cost of the whole equipment has been heavily dominated by the cost of the picture stores, which thus forms the basic cost 'overhead' that influences the whole shape of the design. Given the high cost of the picture stores, it has not in the past been possible to build the digital stills store in the form of a low-cost self-contained studio unit, and instead the pressure has always been on the designer to 'justify' this cost overhead by providing the maximum capacity of on-line disc storage to go with the picture stores, leading to the massive storage capacity (many thousands of stills) typical of the centralised library approach. The same factor has also led to the need to effectively share the picture stores between several production teams by the use of remote access links to studios, as well as to the incorporation into the digital stills store of all manner of 'bells and whistles' in the form of software-based image manipulation functions that, were it not for the need to justify the high cost of the picture stores, would be much more efficiently provided by separate editing or image-processing equipment. The result has been that the needs of production teams for low-cost, moderate-capacity, easy-to-operate digital stills storage has inevitably been subordinated to the needs of the stills librarian, and, however valuable a large efficient stills library may be to any production centre, it should surely be subordinated to the needs of the production teams, not vice-versa!

With Slide File, this forced orientation towards high-capacity library usage has been finally overcome. By using the latest low-cost, high-performance 64k bit RAM devices in a new picture-store design actually used in common by several new Rank Cintel products, both the development and production costs of the system's twin picture stores have been cut to unprecendented levels. With both picture stores actually contained on just two modest-sized printed circuit boards, Slide File has been engineered as a compact low-cost unit that is eminently suitable for self-contained operation in an individual studio or work area. This combination of low cost and physical compactness has been enhanced by the incorporation inside the basic unit of a physically small but highly reliable sealed 'Winchester' disc unit, which offers fast access to an on-line store of realistic capacity, 80 Mbytes or roughly 85 stills, a capacity that detailed research has shown to be more than adequate for the great majority of single productions.

Backing up this on-line store is an off-line storage facility using a novel removable storage medium, the 'streaming' tape cartridge; a pocket-sized tape unit offering robust and reliable off-line storage in conjunction with extremely fast load and store data transfers. The whole Slide File unit is controlled by a powerful 16-bit microprocessor which also supervises the simple but powerful push-button controls that may either be located on the unit itself, or remotely positioned at one or more studio control desks. The result is a new-generation digital stills-store system that in both purchase price and ease of operation is for the first time comparable to all the more generally used items of studio equipment, such as typical modern VTRs.

By installing Slide File, the user can thus bring all the advantages of digital stills storage direct to each of his studios.



Slide File's use of 'streaming' tape cartridge provides convenient, low-cost off-line storage of a realistic number of stills in a form very similar to that of a conventional audio cassette.

STILL STORES

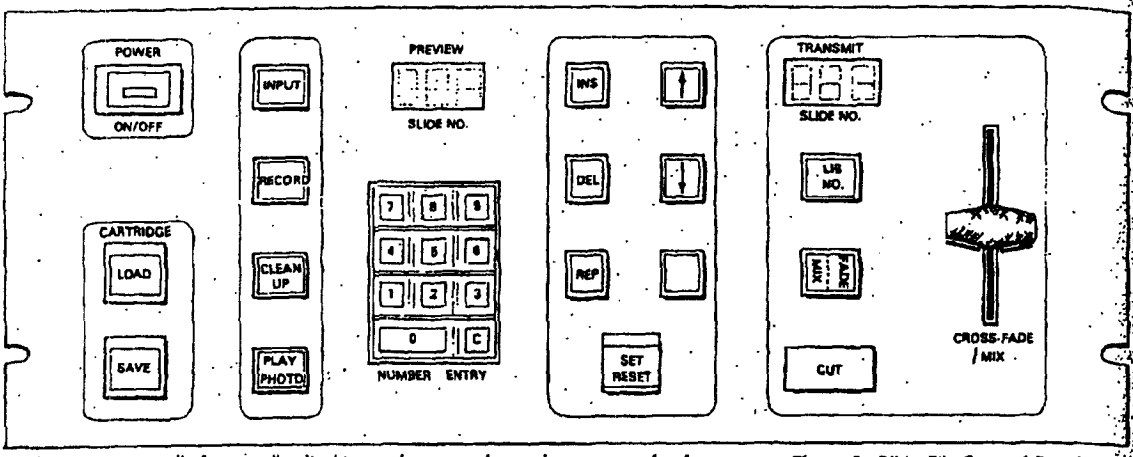


Figure 3. Slide File Control Panel.

and in a very versatile form well suited to the needs of individual production teams. Slide File can accept inputs from practically any live picture source; from conventional slide scanners, electronic artwork generators, studio cameras, even telecines and VTR/VCRs, as well as being loaded with pre-stored stills via its pocket-sized off-line cartridge units.

Inputs are taken in the form of standard RGB analogue signals and then digitally component-encoded in line with internationally accepted standards to provide the highest quality picture standards, with re-conversion to standard RGB analogue components subsequently providing the basic outputs, although facilities for direct digital inputs and outputs allow for the future direct digital connection of Slide File to other digital studio equipment. Once input to the system, stills can be routed by means of simple push-button commands to and from the disc, and also to either the main or monitor ('preview') outputs, between which the operator can straightforwardly cut or cross-fade according to the needs of the programme. Stills stored on the discs can be called up for previewing and/or output either in random order according to a pre-assigned library number, or in an operator-defined sequence previously entered via the control panel. To allow the operator to rapidly scan through the stored stills, a 'polyphoto' facility allows a single pushbutton operation to call up a combined display of any 30 stored stills, each being presented on a reduced scale and clearly captioned with its library number.

Slide File thus provides all the facilities required for the 'user friendly' storage, sequencing and recall of a realistic number of still pictures for any individual production. Extraneous features, such as all the 'bells and whistles' of the picture manipulation facilities provided on some digital stills-store systems, have been deliberately omitted; the idea being that it is both more appropriate and more efficient to provide these facilities through the use of other studio equipment linked to the Slide File.

What Slide File does provide, however, is a unique range of software-based picture-enhancement facilities that have been developed specifically to overcome some of the picture impairments common to all digital still stores, and which are therefore most appropriately and most efficiently provided within the stills-store itself. These unique facilities are accessed by the user through the simple 'clean-up' controls, which allow push-button activation of any of several 'clean-up' modes provided within the system to correct stored images for impairments introduced, for example, by picture movement during 'frame grabbing' from live inputs, or by cross effects arising from the use of composite input signals applied via an external decoder. With very little experience, an operator will be able to quickly select the clean-up mode required for any particular input, and thus ensure that all the stills stored in the Slide File are of the highest quality attainable.

The detailed operation of Slide File is best understood from the block diagram of its main functional units (Figure 2). From this it can be seen that stills are input to the system either via the main RGB 'frame grabbing' input port or via the off-line streaming cartridge; the latter providing a very much more convenient and reliable form of back-up than removable disc packs or makeshift solutions such as the use of VCR tapes, while also holding a realistic number of stills (currently 20) and offering rapid data transfer (12s per frame). However input stills can then be transferred to either of the two picture stores which are connected in turn to the two output ports via a cross-fade/cut switcher unit. Normally, one of these two ports will be treated as the 'main' output, the other as a 'preview' output, and both will be connected to monitors directly visible to the operator, who will thus be able to view simultaneously both the current and next

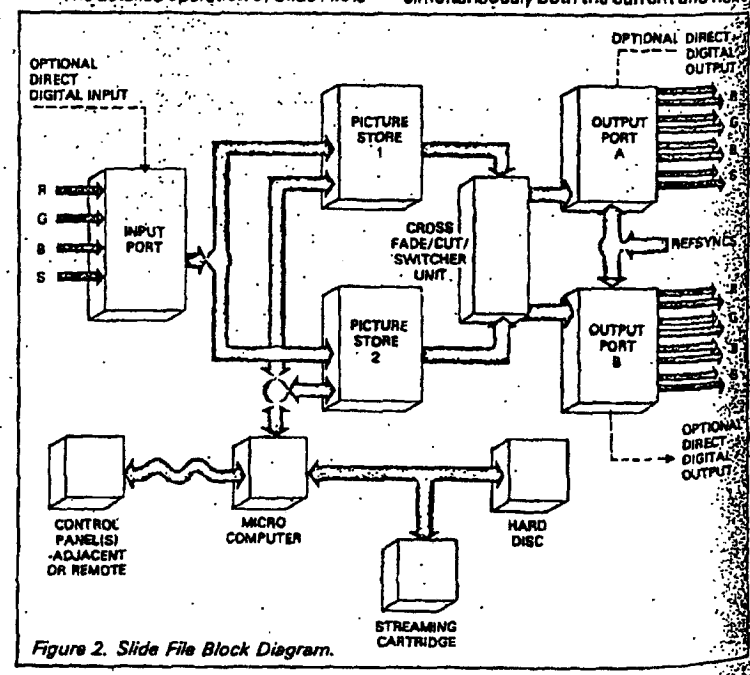


Figure 2. Slide File Block Diagram.

stills in the pre-defined sequence. This pre-defined sequence, as originally keyed in by the operator, is in no sense binding on him. At any time, he can change the sequence, call up different stills from the disc (using a 'polyphoto' display on the preview monitor as a 'contents page'), and grab new stills from the RGB input as desired. All these operations are controlled from the easily understood and ergonomically designed control panel (Figure 3).

All these operations are, of course, supervised by the Slide File's computer, which also carries out the detailed processing work required by the 'clean-up' facilities. Developed as a result of detailed investigation into the picture impairments that can result from typical digital stills-store oprations, these 'clean-up' modes rely on the processor interrogating the relevant picture store and then implementing a series of specially developed algorithms that allow it to modify the picture in a way that automatically adapts itself to the impairments found. In the case of a 'frame grabbed' still affected by inter-field picture movement, for example, the processor will atuomatically identify the areas affected by the movement and interpolate in these areas only in order to remove the bits corresponding to the second field; the other areas of the picture remaining in fully interlaced form and thus keeping their full vertical resolution.

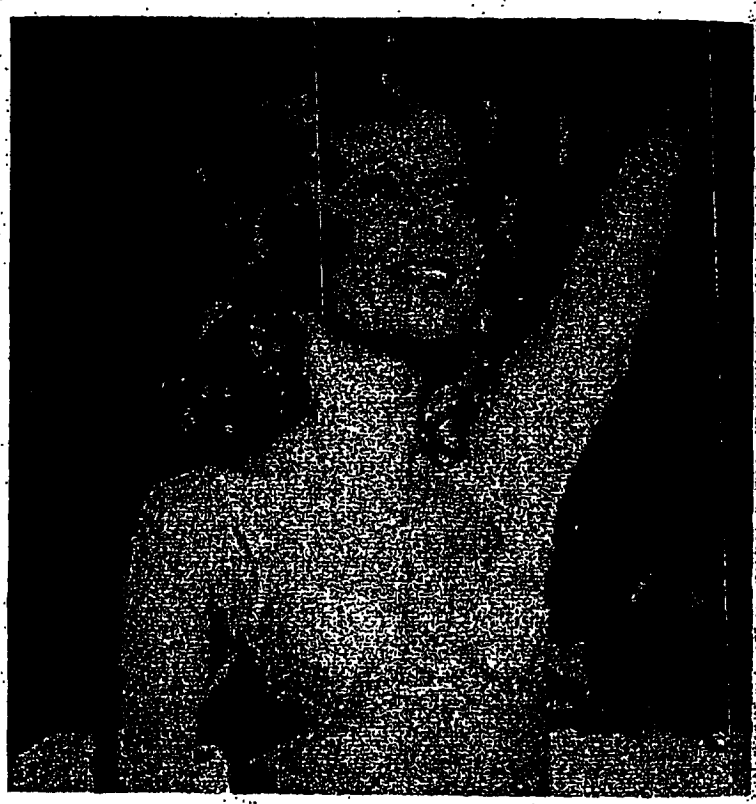
Compared to digital stills-stores that provide for field storage only, or provide for movement correction only by complete-picture reduction from interlaced to single-frame form, this adaptive procedure maintains very high picture quality, reducing the picture down to the overall single-field form provided by other systems only in the very worst of cases. The software for these clean-up procedures, like the rest of the Slide File's software, can be entered directly into the system using the streaming cartridge drive, making future enhancements to the system very easy to incorporate.

The design of Slide File thus reflects a combination of advanced engineering skills and an in-depth appreciation of what is really required of a digital stills store in a working studio environment. This combination stems directly from the system's parentage, based as it is on prototype development by the BBC's Engineering Research Department, followed by re-engineering as a commercial product by Rank Cintel, both of which have brought to the project their unrivalled experience in the development and manufacture of equipment for video applications. Introduced as a commercial product in September 1982, Slide File had even before that had substantial practical use during extensive trials on a number of important BBC productions, some of which, such as the recent *Jane* series, have made special use of graphics stills originated on the BBC/Logica Flair system and, where appropriate, handled via Slide File. Now fully re-engineered, Slide File has already attracted a great deal of interest, with some of the first units sold being destined for use within working UK television studies and also in the post-production centre of a major British facilities house.

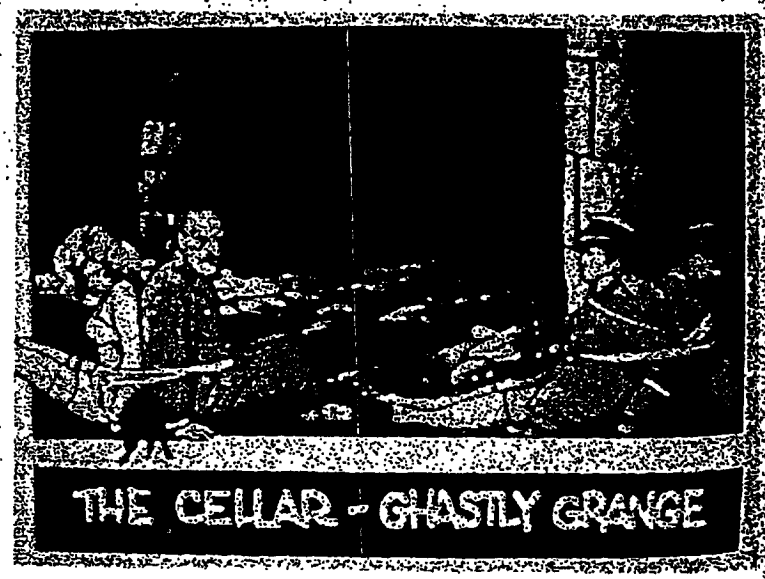
How Slide File will be used in practice will clearly depend on the specific application in which it is employed. Typical examples follow.

Studio Work

In normal studio work, the Slide File will appear to the production team as just another item of studio equipment that they can make use of when engaged in their detailed production work. Typically, the production team will come to the studio with one or more of the Slide File tape cartridges (the direct equivalent of the traditional slide box) with still sequences pre-assembled on them using either the same or another Slide File Unit.



Slide File stills from the BBC Production **Jane**



These pre-as
duction tear
stills storage
series and re
same stills ar
work is over,
next product
takes its cart

Presentat
A very simila
control/prest
will be made
the presenta
transmission
Slide File as a

Graphics
Similarly, a SI
studio using
working on a
some form of
as for transfe
Slide File will
studio may be
its own compr
cluding slide s
oriented digita
into the existir
equipment rat

Film-to-Tap
In post-produc
plementary to
will be in con
Cintel telecine
give full contr
precise colour
frames can easi
scenes later in t
Moreover, onc
Rank Cintel 'Ar
Slide File cartri
repeat transfers
ly by carrying o
using one of the
vides a very co

General Po
With each Slide
a useful collec
cheaply — at a
be stored, han
dard stills can
cassette 'jingle'
tion. With Slide

Further Ap
As well as these
Slide File, how
applications in
tial advantages.
as a form of 'e
way of visuali
medical centres
and cost-effec
tomography an
In fact, wherev
used in the pa
digital storage

Slide File will
team as just
quipment that
on engaged in
ork. Typically,
come to the
the Slide File
equivalent of
with still se-
n them using
lide File Unit.

These pre-assembled Slide File cartridges will provide the production team with an extremely convenient form of portable stills storage, one that will be especially suited to the needs of series and regularly transmitted programmes where many of the same stills are used in each production session. After the studio work is over, the Slide File's store will be cleared ready for the next production team, while the first production team simply takes its cartridges away for use in the next session.

Presentation

A very similar procedure will typically be followed in the master control/presentation studio. A whole day's presentation stills will be made up in advance on cartridges, and then loaded into the presentation studio's own Slide File. When the day's transmission commences, stills can then be fed out from the Slide File as and when the presentation staff choose.

Graphics

Similarly, a Slide File will typically be located in each graphics studio using electronic artwork systems such as Flair. While working on such 'electronic artwork', designers will require some form of long-term storage for their own purposes as well as for transferring their output to its subsequent users, and Slide File will fulfill both these requirements. Such a graphics studio may be only part of a complete graphics department with its own comprehensive range of stills-handling equipment, including slide scanners and perhaps even a conventional library-oriented digital stills store. In any case, Slide File will fit readily into the existing arrangements, complementing other types of equipment rather than competing with them.

Film-to-Tape Post Production

In post-production work too, Slide File will be found to be complementary to existing equipment. One particular application will be in connection with film-to-tape transfers using Rank Cintel telecine equipment, where the capabilities of the telecine give full control over all aspects of the transfer, including precise colour correction. With Slide File, colour-corrected frames can easily be stored for future reference, allowing similar scenes later in the film to be easily and accurately A/B matched. Moreover, once a film has been transferred to tape using the Rank Cintel 'Amigo' scene-by-scene programming system, the Slide File cartridge can be stored with the original film to allow repeat transfers to be made with precise colour matching, simply by carrying out a once-off offsetting operation on the Amigo using one of the Slide File stills. The Slide File cartridge also provides a very convenient source of promotional stills.

General Post Production

With each Slide File cartridge holding a realistic number of stills a useful collection of standard shots can be built up very cheaply — at a cost of only some £2 per still. Because they can be stored, handled and replayed so conveniently, these standard stills can become to video production what the audio-cassette 'jingle' or sound effect has become to audio production. With Slide File, the day of the 'video jingle' has arrived.

Further Applications

As well as these obvious broadcast and post-production uses of Slide File, however, there are also a number of other important applications in which Slide File can be seen to have many potential advantages. These include use in art galleries and museums, as a form of 'electronic exhibition'; in security checking, as a way of visually identifying authorised individuals; and in medical centres, where Slide File can be used to provide flexible and cost-effective storage of output images from X-ray, tomography and other image-producing diagnostic equipment. In fact, wherever conventional photographic stills have been used in the past, Slide File now offers all the advantages of digital storage at low cost and with maximum convenience. □

EXHIBIT 14

Redacted